

B. Existing Allocations Cannot Support Existing, Emerging and Future DSRC-based User Services

While the Commission has recognized the public interest value of many DSRC applications, sufficient spectrum -- as recommended by PSWAC and others -- has not yet been allocated to implement these services. The existing LMS allocation in the 902-928 MHz band has provided a home for the initial deployment of electronic toll systems. However, non-multilateration segments of the LMS band provide access to a total of 14 MHz of spectrum, only 12 MHz of which is contiguous. This simply does not provide sufficient spectrum support to enable the widespread ITS infrastructure established as a national priority by Congress in ISTEA and the robust DSRC deployment needed to support that infrastructure. Nor does this amount of spectrum allow for the deployment of nationally interoperable systems.

Moreover, existing use and regulatory restrictions in the 902-928 MHz band effectively limit the possible DSRC uses of the band. The 902-928 MHz band currently is occupied by both Government and non-Government uses in addition to the LMS usage. These uses are assigned on a priority basis as follows:

- Government radiolocation systems (including NOAA wind profiler radars) and industrial, scientific and medical (ISM) equipment are accorded primary status;
- Government fixed and mobile operations and LMS may not interfere with and must tolerate interference from government radiolocation systems and ISM equipment;
- Amateur radio service licensees and Part 15 unlicensed spread spectrum devices are accorded secondary status.

The intensive use of this band has been well documented in the Commission's determinations in PR Docket No. 93-61 that established the LMS allocation and set forth rules for sharing the band with Part 15 devices. The public safety functions of the DSRC deployment -- which have been recognized and supported by the Public Safety Wireless Advisory Committee -- require a primary

or co-primary spectrum allocation and a band environment hospitable to a full featured DSRC deployment.

Finally, the rules authorizing LMS in the 902-928 MHz band do not permit the implementation of all DSRC applications for ITS purposes. The Commission adopted in its decision in docket 93-61 permissible use limitations that restrict the utility of the LMS allocation for messaging and other functions required to support existing, emerging and future DSRC services. For example, in-vehicle signing cannot be deployed in the band. Thus, the 902-928 MHz band fails to provide the amount, quality and type of spectrum needed for implementation of a large number of DSRC applications.

C. 5.850-5.925 GHz Is An Ideal Candidate Band For DSRC

DSRC systems are best accommodated in the 5.850 to 5.925 GHz band. The propagation characteristics of this band are ideally suited for DSRC. Indeed, DSRC systems have already been effectively deployed in the 5.8 GHz band in other parts of the world. In addition, DSRC use from 5.850-5.925 GHz is consistent with the international table of allocations for region 2 and should be compatible with existing Government and non-Government users of the band.

1. *The Propagation Characteristics of the 5.850-5.925 GHz Band Support All Critical DSRC Requirements*

From a technical perspective, the 5.850-5.925 GHz band is ideal for DSRC. First, the propagation characteristics for the DSRC link must allow for a narrowly-focused and rapidly dissipating signal to enable channel reuse in nearby locations. Second, DSRC systems must be able to transmit up to distances of 30 to 90 meters at relatively low power. Third, DSRC systems must be able to operate in all weather conditions. Thus, any candidate band must suffer minimal

attenuation from the atmosphere in bad weather conditions such as rain, sleet, hail or snow. The 5.850-5.925 GHz band satisfies all of these requirements.<sup>159</sup>

Moreover, any DSRC candidate frequency must provide sufficient bandwidth for ITS services.<sup>160</sup> At the same time, the frequency cannot be so high that the manufacturing cost of the ITS receivers would be prohibitive.<sup>161</sup> As detailed below, the marketplace has already demonstrated that frequency next to the requested band satisfies both of these basic requirements.

2. *DSRC Systems Have Been Successfully Deployed from 5.795-5.805 GHz in Other Parts of the World*

The cost efficient manufacture and deployment of DSRC systems near 5.8 GHz has been proven in marketplaces around the world. The Comité Européen de Normalisation ("CEN"), the governing body for European telecommunications standards, has already approved the 5.8 GHz range (from 5.795-5.805 GHz) for use by DSRC systems.<sup>162</sup> An additional band (from 5.805-

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<sup>159</sup> A comparison of the operating range and environmental limitations was used to assess the performance impact of implementing DSRC operations in the 5.850-5.925 GHz band relative to the 902-928 MHz band. The actual range of operation was the first factor evaluated. The received signal level is dependent on the square of the wavelength and the received signal level in a one-way communications link is inversely related to the frequency squared. Calculating the ratio  $5.9 \text{ GHz} / 915 \text{ MHz} = 6.34$  indicates that the received signal power is reduced by a factor of  $(6.34)^2 = 40.2$  or 16 dB. For those DSRC systems that use passive or reflective transponders, the two-way loss is 32 dB.

DSRC equipment in the 5.850-5.925 GHz range operate with power outputs of 3 to 10 dB higher than the 902-928 MHz equipment and with transceiver sensitivities 20 to 30 dB lower (greater sensitivity). The noise level is much lower at the 5.850-5.925 GHz range, so higher receiver sensitivity is possible. The combination of higher power and improved sensitivity make up the 32 dB larger propagation loss.

<sup>160</sup> See, e.g., *Spectrum Requirements for DSRC* at 61-62.

<sup>161</sup> It is anticipated that the cost of in-vehicle DSRC communication equipment can be kept between \$20 and \$100 in the U.S., see *Spectrum Requirements for DSRC* at 62, ensuring that the benefits of DSRC can be widely and equitably distributed as mandated by ISTEA, 102 P.L. §2.

<sup>162</sup> Newman, D. and B. Barink, "Follow the Wave(length): Comparing the 915 MHz and 5.8 GHz AVI Systems," *Traffic Technology International* at 89 (June/July 1996).

5.815 GHz) may be allocated for additional applications.<sup>163</sup> Many Asian countries, including Japan, Singapore and Korea, have also accepted the 5.8 GHz ISM band for use by these systems.<sup>164</sup> A sampling of deployments in the band are described below:

- Thomson-CSF has installed an open-highway tolling system in France on the A42 and A5 roadways using a system called Mistral that operates from 5.795-5.805 GHz.<sup>165</sup> The system operates on two lanes in either direction on both roadways. These installations have successfully operated for over a year.
- Saab-Combitech, a Swedish firm, has installed a free-flow toll system in Austria, on the Tauernautobahn, in the area of the St. Michael tollplaza.<sup>166</sup> Traffic heading from north to south uses a three-lane, high-speed, full multi-lane 5.8 GHz microwave toll station about 1.5 km north of the St. Michael tollplaza. Northbound traffic uses a high-speed, single-lane, 5.8 GHz microwave toll station at Katschberg North, where only a single lane is available. The specification requires the system to achieve 98 percent levels of accuracy. Early indications are that the system is meeting or exceeding the specifications required by the Austrian highway authority.
- In an Asian effort, Saab-Combitech has been selected to build a toll collection system for the Tate's Carin Tunnel in the 5.8 GHz range. The tunnel serves Hong Kong and the Kowloon peninsula and is the longest tunnel in Asia. A daily traffic load of 82,000 vehicles is supported by this facility. The system will begin operation on a trial basis for 1,000 vehicles.

There is little question that DSRC systems operating at or near 5.8 GHz can be manufactured on a cost effective basis for marketing around the world. However, in order for the United States public to reap the benefits of DSRC operation in this band, the Commission should amend its rules as requested herein.

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<sup>163</sup> Büchs, J.D. *et al.*, *Access Control System Based on the Emerging European Standard for 5.8 GHz Short Range Communications* at 1806 (undated).

<sup>164</sup> "Follow the Wave(length)."

<sup>165</sup> "Mistral meets Euro-standards in advance," *ITS Magazine* at 73 (March 1996).

<sup>166</sup> Smith, P., "Alpine trials for Austro-Swedish Venture," *ITS Magazine* at 68 (March 1996).

3. *An ITS Allocation in the 5.8 GHz Band Is Consistent with the ITU Table of Allocations for Region 2*

The international allocation for the 5.850-5.925 GHz band in Region 2 (which includes the United States) contains fixed, fixed-satellite (earth-to-space), and mobile on a primary basis, and amateur and radiolocation on a secondary basis. In the United States, this band is currently allocated to radiolocation and fixed-satellite (earth-to-space) on a primary basis,<sup>167</sup> and amateur use on a secondary basis.<sup>168</sup> DSRC operation in the 5.850-5.925 GHz band thus requires that a new allocation for mobile service be added to the current United States allocations, but requires no international coordination.

D. DSRC Systems Are Compatible with Existing Uses of the Spectrum and Can Operate from 5.850-5.925 GHz with Minimal Interference

Technical analysis indicates that ITS services can operate on a primary basis with existing government and non-government users in the 5.850-5.925 GHz band. The low power transmissions from ITS services provide little likelihood of harmful interference to any current users. Similarly, existing uses of the spectrum are unlikely to pose a threat of interference to DSRC. Studies of the radiators in and around this band indicate that the band is generally low in background emissions with out-of-band emitters providing the main source of potential interference to DSRC systems.<sup>169</sup> As explained below, out-of-band interference can be reduced with the use of mitigation techniques, allowing DSRC systems to operate in an environment with minimal noise and manageable interference sources.

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<sup>167</sup> The FSS is allowed in this band on a case-by-case basis with an EMC analysis per the Table of Frequency Allocations, footnote US245.

<sup>168</sup> 47 C.F.R § 2.106.

<sup>169</sup> *Spectrum Requirements for DSRC* at 71-73.

## 1. Government Services

The 5.850-5.925 GHz band is currently allocated to Government Radiolocation on a primary basis. Military tracking and drone-controlled radars, operated primarily on remote test ranges, are the dominant equipment types under this service. FHWA and the Department of Defense ("DoD") are currently developing a test program to identify and alleviate interference concerns pursuant to the terms of a *Certification of Spectrum Support for ITS* issued by NTIA on May 23, 1996.<sup>170</sup>

NTIA's *Certification of Spectrum Support for ITS* authorizes the experimental deployment of DSRC in the 5.850-5.925 GHz band. Among other things, the certification directs FHWA to perform coordinated testing with the DoD in areas likely to suffer the greatest interference threat to either DoD or DSRC systems. These coordination and testing activities are currently ongoing. Given the nature of DoD emitters in this band, suitable mitigation techniques (*e.g.* filters and overpower protection) should alleviate any concerns. ITS America considers this an important step that must be taken in order to ensure the reliability of the DSRC system.<sup>171</sup>

ITS America is committed to ensuring that DSRC transceivers will allow for predicted and measured incident power levels from military radars without a risk of damage to transceivers even though DSRC systems typically will not operate in proximity to radars. Furthermore, DSRC

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<sup>170</sup> See Land Mobile Spectrum Planning Options, NTIA Special Publication 95-34 at 3-8, 9 (Oct. 1995); NTIA Form 44, *Certification of Spectrum Support for Intelligent Transportation Systems*, SPS-10757/3 (May 23, 1996) (attached as Appendix J).

<sup>171</sup> ARINC is currently in the process of testing possible interference to DSRC-based systems from Government use of the radiolocators. ITS America will submit the test results to the Commission when available. In addition, FHWA is in discussion with DoD and NTIA regarding use of the 5.850-5.925 GHz band for DSRC services. ITS America will keep the Commission apprised of the progress of these discussions.

transceiver antennas will be oriented either downward or horizontally, decreasing even further the likelihood of interference with government radar systems.

## 2. *Fixed Satellite Service and ISM Operators*

Non-government uses of the 5.850-5.925 GHz band include fixed satellite earth-to-space uplinks and ISM, along with amateur radio operators authorized on a secondary basis and Part 15 devices. Interference studies indicate that DSRC systems can co-exist with all existing users with employment of currently available mitigation techniques.

Fixed satellite uplinks constitute the primary non-governmental use of the 5.850-5.925 GHz band. ARINC has examined this use of the band with DSRC operation and has concluded that there are no significant interference concerns between DSRC and FSS use.<sup>172</sup> Currently, a relatively small number of earth-to-satellite fixed stations exist in the band.<sup>173</sup> Because there are few of these fixed-station emitters, DSRC transceivers can easily be located to avoid interference. Moreover, fixed-satellite earth-to-space emitters use high-gain, low sidelobe antennas pointed away from the earth. Low sidelobe antennas, utilized to avoid interference with other satellites, will also significantly reduce the interference potential with DSRC systems. Conversely, the low radiated power levels of DSRC systems will diminish any interference with satellite communications.

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<sup>172</sup> See Assessment of Potential Interference to the Fixed Satellite Service (FSS) Uplinks from the Proposed ITS DSRC System (attached as Appendix K) for a more detailed analysis of the interference potential with fixed satellite services. FHWA and ITS America have worked with the fixed satellite service to examine and address any potential interference issues.

<sup>173</sup> See *Spectrum Requirements for DSRC* at 71 for the location of fixed satellite earth-to-space links.

FCC rules authorize ISM devices to operate from 5.725-5.875 GHz. ITS America is not aware of any ISM devices currently operating in the band.<sup>174</sup> Furthermore, LMS systems operating from 902-928 MHz co-exist with ISM devices with minimal interference, indicating a low probability of interference with any potential ISM users in the 5.850-5.875 GHz band. Finally, the use of mitigating techniques, such as roaming channel selection, can greatly minimize DSRC-based interference potential with ISM devices and other in-band and out-of-band users.<sup>175</sup>

### 3. *Amateur Radio Operators*

Amateur radio operators are authorized to operate from 5.650-5.925 GHz on a secondary basis. FHWA and ITS America are currently working with representatives of the American Radio Relay League to examine jointly any potential interference issues between amateurs and DSRC-based systems.

### 4. *Part 15 Devices*

Section 15.249 of the Commission's Rules govern unlicensed operation in the 5.850-5.875 GHz band. Currently, ITS America is aware of one party, ReSound Corporation, that plans to deploy a product in this band segment. ITS America is committed to working with ReSound to develop a potential sharing plan for this band segment.

### 5. *Out-Of-Band Users*

The potential for interference with DSRC systems increases when emitters in bands adjacent to 5.850-5.925 GHz are considered (although potential interference from DSRC systems to these users remains small). For example, the 5.650-5.850 GHz band sustains a greater number

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<sup>174</sup> See NTIA Report No. 93-294 at 56 (February, 1993).

<sup>175</sup> See, e.g., *Spectrum Requirements for DSRC* at 74 (discussing current mitigation techniques employed by DSRC systems to reduce interference, including directional antennas, power controls and FM capture techniques).

of radiolocation, amateur and ISM operators than the 5.850-5.925 GHz band.<sup>176</sup> Furthermore, the 5.925-7.075 GHz band is used for earth-to-space fixed communications and for public and private fixed communications links which can operate at high power (over 3 kW) and over considerable distances. A large number of these emitters operate at the edge of the 5.850-5.925 GHz band.

Technical measures can greatly minimize any potential interference from these users. For example, filtering devices added to DSRC transceivers can reduce or eliminate out-of-band interference.<sup>177</sup> In addition, a multi-stage transponder wake-up scheme can be incorporated to reduce activation from out-of-band emitters. Transponders operating in the 902-928 MHz band currently employ this technique. Finally, the ability to select an alternative channel for operation when located near a disruptive source ensures that DSRC systems can avoid interference from in-band and out-of-band users. ITS America realizes that the potential for interference may decrease DSRC system reliability and user acceptance. We fully support the ongoing efforts of FHWA, DoD, the Fixed Satellite Service, and Radio Amateurs in their efforts to identify and alleviate all potential interference concerns.

E. The Proposed Rules Will Accommodate All of the Competing Standards and Technologies for DSRC, Ensuring a Competitive Marketplace

Many organizations are currently working toward developing DSRC standards, although no standard has yet been officially adopted in the U.S. or abroad.<sup>178</sup> Some of these efforts are

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<sup>176</sup> See, e.g., *Spectrum Requirements for DSRC* at 73 (graphic depiction of all licensed emitters in or adjacent to the 5.850-5.925 GHz band).

<sup>177</sup> See *id.* at 72-73.

<sup>178</sup> See DSRC Standards Discussion (attached as Appendix L). The draft standards referenced *infra* are appended as attachments to Appendix L.

near completion. For example, a European Prestandard, "CEN TC278, DSRC Physical Layer using Microwave at 5.8 GHz," is currently under consideration for adoption by the European Union.<sup>179</sup> A Japanese draft standard, "Road Traffic and Transport Telematics (RTTT) DSRC Standard Using Microwave in Japan," which operates throughout the 5.8 GHz ISM band, may also soon be submitted to the International Telecommunications Union for its consideration.<sup>180</sup> Other standards organizations, including ASTM and ISO/TC204, are in the process of examining existing DSRC standards information, including European and Japanese proposals, to formulate the development of a U.S. standard.

The European Prestandard operates from 5.795-5.805 MHz and supports two five MHz channels, very short frequency reuse distances and a range of up to 15 meters. Because of its relatively short transmission range, the European Prestandard generally supports only very short range DSRC applications, like electronic toll collection and access control. Many of the DSRC-based applications described above -- including the intersection collision warning system, weigh-in-motion, in-vehicle signing, and the DSRC elements of the automated highway system -- could not be implemented under the European Prestandard without extensive and significantly more expensive deployment of roadside equipment.

The Japanese draft standard shares similar frame structures with an American proposed standard for 915 MHz operation: "Hughes Transportation Management Systems (HTMS) VRC Reader-Transponder RF Protocol Specification." Equipment based on the Japanese and Hughes draft standards supports two ten MHz channel pairs, short frequency reuse distances and a range

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<sup>179</sup> See Attachment 3 to Appendix L.

<sup>180</sup> See Attachment 4 to Appendix L; *see also* Attachment 5 (summarizing major features of the Japanese draft standard).

of 50 meters. In addition, the Japanese draft standard specifies that each downlink and uplink carrier frequency pair be separated by 40 MHz. It is not yet clear how many DSRC-based applications the Japanese draft standard can support. However, it appears designed to support primarily electronic toll collection, vehicular navigation systems, and research and development into other ITS systems -- significantly fewer applications than ITS America seeks to support here.<sup>181</sup>

The type of transponder used is one of the most significant distinguishing characteristics between the various proposed standards for DSRC. Two basic designs of transponders are currently in use: active and backscatter. The European Prestandard relies on use of a backscatter transponder, which reflects and modulates the transceiver signal. The Japanese draft standard, in contrast, uses an “active” transponder, designed to transmit a return signal. ARINC summarizes the difference between the two designs as follows:

Active tags have a longer range than the backscatter designs given the same reader antenna output power. However, the active tag would need a complicated transmitter to transmit at different frequencies. Therefore, it would need to be larger, cost more and use more power than similarly capable backscatter tags. The backscatter tag has the ability to respond to different frequencies that the reader may use without requiring more circuitry and packaging space. In addition, backscatter tags usually cost less than active tags. ...[However], where two or more vehicles are communicating and a substantial line-of-sight is desired, the active type would require less reader output power and would be less subject to interference. ...[W]here precise location is required with only one vehicle at a time, the backscatter system would require less power from the tag, cost less, and be more compatible with small separation distances between applications.<sup>182</sup>

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<sup>181</sup> Attachment 4 to Appendix L at 3.

<sup>182</sup> *Spectrum Requirements for DSRC* at 5.

Because of the relative advantage of each type of transponder in different application scenarios, DSRC systems currently employ both active and backscatter transponders, as well as a combination of the two.<sup>183</sup>

ITS America will continue to work with industry, government and standards organizations in developing a consensus approach to a U.S. DSRC standard and will keep the Commission informed of the status of those standard-setting efforts.

## VI. CONCLUSION

In docket 93-61, the Commission recognized the "expected growth of ITS" and acknowledged its intention to "allocate additional spectrum or create new services intended to further the efficiency of the nation's transportation infrastructure."<sup>184</sup> An additional allocation is now necessary to accommodate the needs of both present and future DSRC services. A piecemeal approach to spectrum allocations will impede the deployment of nationwide and integrated safety-enhancing ITS services and keep the United States behind the rest of the world in the evolution of this technology. To allow for full planning and deployment of this emerging technology, an allocation of 75 MHz of contiguous spectrum for ITS-related DSRC systems is in the public interest.

Deployment of short-range, vehicle-to-roadside communication systems as part of a national ITS architecture is critical to improving the safety and efficiency of road transportation in the United States. Allocation of the frequency band from 5.850-5.925 GHz supports the widest range of DSRC applications while minimizing the potential for interference. It also promotes a competitive DSRC marketplace. The Commission should act without delay to allocate DSRC

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<sup>183</sup> *Id.*

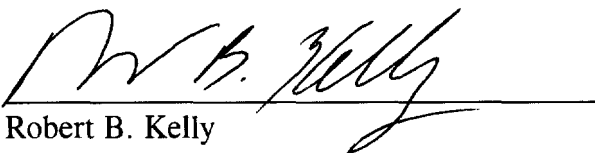
<sup>184</sup> *LMS R&O* at ¶ 6.

operations co-primary status with fixed-satellite (earth-to-space) and radiolocation operations in the 5.850-5.925 GHz band.

For these reasons, ITS America urges the Commission to commence expeditiously a rulemaking proceeding looking toward a co-primary allocation of the 5.850-5.925 GHz band for ITS DSRC.

Respectfully submitted,

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# APPENDIX A

## ITS America Membership List

## ITS America Participating Members List

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AAA Florida	Associacao Brasileira de Concessionaries de Rodovias - ABCR	Castle Rock Consultants
AB Volvo	Association of American Railroads (AAR)	Castle Tower Corporation
AC Transit	Association of Electronic Technology for Automobile Traffic and Driving (JSK)	Centennial Technologies Inc.
Active Traffic Management, Inc.	AT/Comm, Incorporated	Center for Urban Transportation Research University of South Florida
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ALK Associates, Inc.	Baltimore County-DPW	Chicago Transit Authority (CTA)
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Canadian Highways International Corp.	Barco Visual Systems	Cinergy Innovations, Inc.
Alliance for Transportation Research (ATR)	Base Technologies, Inc.	City of Anaheim
AlliedSignal Technical Services Corporation	Battelle	City of Atlanta
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Detection Systems And Engineering Co.	Federal Highway Administration-Office of Motor Carrier Safety & Technology	Hillsborough County Engineering & Construction Services
Detroit Department of Transportation	Federal Highway Administration-Office of Safety and Traffic Operations R & D	Hillsborough County Metropolitan Planning Organization
DGD Enterprises, Inc.	Federal Railroad Administration	Hitachi, Ltd.
Digital D.J. Incorporated	Federal Transit Administration	HITEC & Civil Engineering Research Foundation (CERF)
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DKS Associates	Fiber Options, Inc.	Hogan & Hartson
DOT City of Colorado Springs	Fiber Technologies Group	Honda R&D North America, Inc.
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Dunn Engineering Associates	Florida Toll Services	Ian Catling Consultancy
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Intelligent Transport Systems Australia,  
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International Bridge, Tunnel and  
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Association  
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International Road Federation  
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ITS Arizona  
c/o BRW, Inc.  
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ITS Rocky Mountain  
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ITS World  
J.W. Leas & Associates, Inc.  
Jacki Bacharach and Associates  
Jaffe Engineering and Development  
Industries  
James Causey & Associates  
Japan Traffic Management  
Technical Association  
Javelin Systems  
Jet Propulsion Laboratory  
JETRO New York

Johns Hopkins University  
Johnson, Mirmiran & Thompson PA  
K & A Industries  
Kaman Sciences Corporation  
Kan Chen, Inc. (KCI)  
Kansas City Area Transportation Authorit  
Kansas Department of Transportation  
Kansas Turnpike Authority  
Kelly & Povich, PC  
Kentucky Department of Transportation  
Kentucky State University  
Kessmann & Associates, Inc.  
Ketrion Division of the  
Bionetics Corporation  
KG Rear Vision  
Kimley-Horn and Associates, Inc.  
King County Department of Transportation  
Kitsap Transit  
KLD Associates, Inc.  
KOIN Center  
Korea Road & Transportation Association  
Kotera Consultants, Inc.  
KSI Inc.  
L & C Marketing Group  
L.S. Gallegos & Associates, Inc. (LSG&A)  
LACMTA  
Lawley Publications  
Lee County Department of Transportation  
Lee Engineering, Inc.  
Lightstone Group, Inc.  
Liikkuva Systems International, Inc.  
Lobron Consultancy, Limited  
Lockheed Martin  
Logistics Management Institute  
LORAL  
Los Angeles County Department Of Public  
Louisiana Transportation Research Center  
Lyle Saxton, Transportation Consultant  
LYNX  
Maguire Group Inc.  
Mando America Tech Center, Inc.  
Manitto Technologies, Inc.  
Mansell Associates  
Maricopa County Department of  
Transportation (MCDOT)  
Mark IV Industries Ltd.  
Marquette University  
Metropolitan Atlanta Rapid Transit  
Authority (MARTA)  
Martin Enterprises & Associates, Inc.  
Maryland Department of Transportation  
Maryland National Capital  
Park & Planning Commission  
Maser Sosinski & Associates  
Massachusetts Bay Transportation  
Authority

Massachusetts Highway Department  
Massachusetts Institute of Technology  
(MIT)  
Massachusetts Port Authority  
MATRIX Corporation  
Matrix Management Group, Inc.  
Matsushita Communication Industrial Co.  
Matsushita Electric Industrial Company,  
Ltd.  
Maximal Software, Inc.  
Mazda R&D North America  
Meister Electronics, LC.  
Meridian Technologies, Inc.  
MERRA  
Metro  
Metro Dynamics  
Metro Tulsa Transit Authority  
Metropolitan Washington Council  
of Governments  
Metropolitan Transit Authority of  
Harris County, Texas (Houston METRO)  
Metropolitan Transportation Authority  
Metropolitan Transportation Commission  
(San Francisco Bay Area)  
Meyer, Mohaddes Associates Inc  
MFS Network Technologies  
Miami Valley Regional Planning  
Commission  
Michael Baker Jr., Inc.  
Michigan Department of State Police  
Michigan Department of Transportation  
Michigan State University  
Micron Communications, Inc.  
Microwave Sensors, Inc.  
Mid-Willamette Valley Council Of Governm  
Midwest Traffic Products, Inc.  
Mil-lektron  
Ministry of Communications  
Ministry of Transport, Public Works and  
Management  
Minneapolis Public Works Department  
Minnesota Department of Transportation  
Minnesota Guidestar  
Minnesota Guidestar  
Missouri Department of Transportation  
Mitre  
Mitretek Systems, Inc.  
Mitsubishi Electric Corporation  
Mitsubishi U.S.A. Motors Corporation  
MK Centennial  
Monmouth County Board of Chosen  
Freeholders Traffic Safety Engineerin  
Montana Department of Transportation  
Monterey Technologies, Inc.  
Montgomery County Department of  
Transportation

## ITS America Participating Members List

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Morgan State University	Orbital Communications Corporation (ORBCOMM)	Rizzo Associates, Inc.
Moss & Rocovich, Attorneys-At-Law, P.C.	Orbital Sciences Corporation	Road Commission for Oakland County
Motorola	Orchard, Hiltz & McCliment, Inc.	Road Commission Of Macomb County
MPO For The Miami Urbanized Area	Oregon Department of Transportation	Road Traffic Safety Association
Multidyne Inc.	Orlando-Orange County Expressway Authority	RoadTrac
Multisystems, Inc.	Orth-Rodgers & Associates, Inc.	Robert Bosch Corporation
Municipality of Metro Toronto	P.K. Contracting	Robert L. French & Associates
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MZB Video Solutions, Inc.	Pacific Rim Resources	Rockwell International Corporation
National Engineering Technology Corp.	PADECO Co., Ltd.	Rothleder-Lowenthal Group, LLC
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National Private Truck Council	Parsons Transportation Associates	Sabra & Associates, Inc.
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NC Central University	PB Farradyne Inc.	Safety Research Associates, Inc.
Nebraska Department Of Roads	Peajes S.A.	Safety Warning System
NEC Corporation	Peek Traffic - Transyl	SAIC, Inc.
Nestor, Inc.	Peek Traffic, Inc.	An SAIC Company
Network Construction Services, Inc.	Peninsula Transportation District Commis Pentran	San Diego Metropolitan Transit Developme
New Jersey Alliance for Action	Pennsylvania Department of Transportation (PennDOT)	San Diego Service Authority
New Jersey Highway Authority	Pennsylvania Transportation Institute	for Freeway & Expressways
New Jersey Institute of Technology	Pennsylvania State University	Sandia National Laboratories
New Jersey Transit Corporation	Pennsylvania Turnpike Commission	Santa Clara Valley Transportation Author
New Jersey Turnpike Authority	Perteet Engineering, Inc.	Santa Fe Technologies, Inc. (SFT)
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Nissan Motor Company, Ltd.	Port Of Portland	Schwartz Electro-Optics, Inc.
North Carolina Department of Transportation (DOT)	Portland Area Comprehensive Transportation Committee (PACTS)	Schwartz Electro-Optics, Inc.
Northeastern Indiana Regional Coordinating Council	Portland State University	The Scientex Corporation
Northeastern University	Post, Buckley, Schuh & Jernigan, Inc.	Scientific Technologies, Inc.
Northern Technologies, Inc.	Potomac & Rappahannock Transportation Commission	Seelye Stevenson Value & Knecht (STV Incorporated)
Northwestern University, Transportation Center	Power Max Consulting	SEI Information Technology
NOVA Laboratory, Inc.	PRC Inc.	Seiko Communications Systems, Inc.
Nu-Metrics	Princeton University	Shadow Broadcast Services
Oak Ridge National Laboratory	Prism Video	Sharon Greene and Associates
Oakland County Government	Public Technology, Inc.	Short Elliott Hendrickson, Inc.
Ohio Department of Transportation (ODOT)	PULNiX	Siecor Corporation (A Corning Inc. Company)
Oklahoma Department of Transportation	Purdue University	Siemens Automotive Corp.
Oklahoma Highway Patrol	School of Civil Engineering	Sigmund Silber & Associates
Oklahoma Turnpike Authority	QED Transportation Weather Consultants	SIRF Technology
Omron Corporation	Raytheon Company Inc.	SIRIT Technologies Inc.
Ontario Ministry of Transportation	Regional Transportation District	Skyline Products, Inc.
Optech Systems Corporation	Research & Special Programs Administration	SmartRoute Systems, Inc.
	Riverside County Transportation Commission	Society of Automotive Engineers (SAE)
		Sonic Systems Corporation
		South Carolina Department of Transportation
		South Coast Air Quality Management District
		Southeast Michigan Council of Governments (SEMCOG)

## ITS America Participating Members List

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Southern California Association of Governments	TranSmart Technologies, Inc.	University of Texas at Austin
Southwest Ohio Regional Transit Authority/Metro	Transpo Industries	University of Washington
Southwest Research Institute	Transport Canada	Transportation Northwest (TransNow)
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SRI International	Transportation Institute	Utah Department of Transportation
Stan Smith Consulting	N.C. A & T University	Utility Consultants, Inc.
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Sverdrup Corporation	TRW, Inc.	Volpe National Transportation Systems Center (USDOT)
Swedish National Road Administration	Turner-Fairbank Highway Research Center	Volvo Cars of North America, Inc.
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System Resources Corporation	U.S. Business & Industrial Council	Wash. State Transportation Commission
Systems Technology, Inc.	UMA Engineering	Washington State Dept. of Trans.
TELE ATLAS bv	United Motorcoach Association (UMA)	Wayne State University
Tele Tran Tek Services	United Parcel Service (UPS)	Weather Solutions Group
Telecommunication & Industrial Consulting Services Corporation	United States Department of Transportation (U.S. DOT)	Western Transportation Institute
Telspan International, Inc.	United States Department of Transportation Library	Civil Engineering Department
Texas Department of Transportation	United Technologies Automotive	Westwood Professional Services
Texas Instruments Inc.	Universal Traffic Management Society (UTMS) of Japan	Whitney, Bailey, Cox & Magnani
Texas Transportation Institute	Universidad Nacional de San Luis	Wilbur Smith Associates
Thaw Associates	University of Arizona	Wilson Consulting
The Esther Gerber Trust	University of California - Berkeley	Winsted Corporation
The Hoosier Company, Inc.	California PATH Program	Winston-Salem Transit Authority
The Institute of Navigation	University of California - Davis	Wisconsin Department of Transportation (WisDOT)
The Naidus Group, Inc.	AHMCCT	Woolpert
TNO Netherlands - Organization for Applied Scientific Research	University of Florida	Xanavi Informatics Corporation
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Tracer Net Corporation	University of Illinois at Urbana Champaign	ZEXEL USA Corporation
Traffic & Parking Control Co., Inc. (TAPCO)	University of Illinois at Chicago	[MG]2, Inc.
Traffic Control Corporation	Urban Transportation Center	
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Traffic Improvement Association of Oakland County	University of Kentucky	
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TRAFIX, Inc.	University of Massachusetts - Amherst	
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Transcraft	ITS Research Center of Excellence	
Transformation Systems, Inc.	University of Minnesota	
	Center for Transportation Studies	
	University of Nebraska-Lincoln	
	Center for Infrastructure Research	

# APPENDIX B

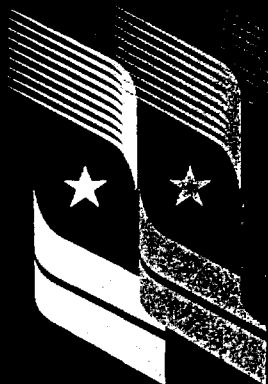
IVHS America; *Strategic  
Plan for Intelligent  
Vehicle-Highway Systems  
in the United States* (May  
20, 1992) (excerpts)

STRATEGIC PLAN FOR

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# Intelligent Vehicle-Highway Systems

in the United States



Prepared by IVHS AMERICA

May 20, 1992

## I. EXECUTIVE SUMMARY

### Introduction: The Needs

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*"The mobility we prize so highly  
in the United States  
is threatened."*

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Surface transportation in the United States is at a crossroads. The mobility we prize so highly is threatened. Many of the nation's roads are badly clogged. Congestion continues to increase, and the conventional approach of the past — building more roads — will not work in many areas of the country, for both financial and environmental reasons.

Safety continues to be a prime concern. In 1991, 41,000 people died in traffic accidents, and more than 5 million were injured. Public transportation systems, chronically short of funds, are seen by many as an unattractive alternative to driving.

Congestion takes its toll, too, in lost productivity, costing the nation an estimated \$100 billion each year. Traffic accidents — many caused by congestion itself — drain away another \$70 billion per year. Numbers alone can't measure the loss of life or consequences of long-term injury. There are also other costs. For example, inefficient movement of vehicles reduces productivity, wastes energy, and increases emissions; trucks, buses, and automobiles idled in traffic waste billions of gallons of fuel and needlessly emit tons of pollutants each year.

Recognition of these problems led to the passage of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), signed by President Bush on December 18, 1991. The purpose of ISTEA is clearly announced in its statement of policy: "...to develop a National Intermodal Transportation System that is economically efficient and environmentally sound, provides the foundation for the Nation to compete in the global economy, and will move people and goods in an energy efficient manner."

## IVHS: An Answer

### Goals for IVHS in the U.S.

- Improved safety
- Reduced congestion
- Increased and higher quality mobility
- Reduced environmental impact
- Improved energy efficiency
- Improved economic productivity
- A viable U.S. IVHS industry

There is no single answer to the set of complex transportation problems that confront us. But a group of technologies known as Intelligent Vehicle-Highway Systems (IVHS) can help tremendously in meeting the goals of ISTEA. Indeed, Congress recognized this in the Act by authorizing a \$660 million IVHS program over the next six years. IVHS is composed of a number of technologies, including information processing, communications, control, and electronics. Joining these technologies to our transportation system can save lives, save time, and save money.

IVHS can improve safety, reduce congestion, enhance mobility, minimize environmental impact, save energy, and promote economic productivity in our transportation system. It will multiply the effectiveness of future spending on highway construction and maintenance and will increase the attractiveness of public transportation. IVHS will be as basic a transportation raw material as concrete, asphalt, or steel rail.

The challenge lies in the diversity of IVHS. The technology is highly interdisciplinary, ranging from physics to psychology. The public arena is equally diverse, demanding new working relationships among all levels of government. New public/private partnerships must be formed. Legal issues such as product liability and privacy must be addressed. Many participants in IVHS compete for resources and customers; many have objectives and constituencies at odds.

If IVHS is to succeed, however, this diversity must generate concerted action — a coherent national program of technical exploration and operational tests leading to deployment across the continent. Research must be planned, executed, and coordinated. Institutional and legal barriers must be addressed and their effects mitigated. Both public investment and private investment in IVHS are crucial. The effort to secure such funding must begin now.

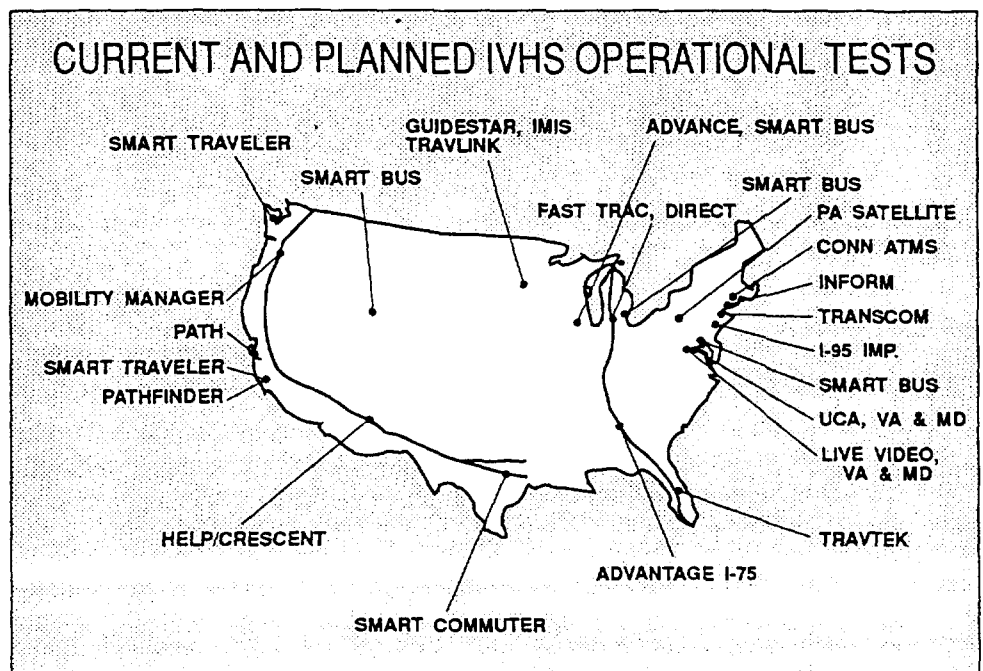
IVHS is not a distant vision. Already, real systems, products, and services are being tested throughout the U.S. Some first-generation systems are, in fact, on the market or are being developed. These systems:

- Collect and transmit dynamic information on traffic conditions and transit schedules for travelers, whether they are at home, in the office, or en route. Alerted to hazards and delays, they are able to change their plans to minimize inconvenience.
- Expand the capacity of our highways by reducing the number of traffic incidents, clearing them more quickly when they occur, rerouting traffic flow around them, and automatically collecting tolls.

- Improve the productivity of commercial, transit, and public safety fleets by using automated tracking and dispatch systems that dynamically reroute vehicles to accommodate changes in customer needs.
- Assist drivers in reaching a desired destination with navigation systems enhanced with pathfinding, or route guidance. Stored directories that are part of such systems will provide information on nearby businesses or tourist attractions.

More than 20 real-world operational tests are now under way or are planned as federal/state/private ventures to evaluate more advanced IVHS concepts and components than those described above. The figure below highlights a number of those tests.

With significant R&D programs under way, the future holds the promise of even more-advanced products and services. These include collision avoidance systems that will prevent many accidents and in-vehicle signage that will display information about road conditions, including curves, speed limits, and construction projects. Research is being done on route guidance systems that will automatically incorporate traffic information, providing drivers with the fastest routes and allowing them to skirt delays; enhanced vision systems that will cut through the dark, fog, and dust to show the driver the road ahead; and systems that will automatically weigh trucks — and uniquely identify them — as they pass “transparent” state and international borders.



## Benefits

Over the next 20 years, a national IVHS program could have a greater societal impact than even the Interstate Highway System. As with the Interstate, effects are difficult to predict at the outset of the program. In view of this, the Strategic Plan envisions a series of R&D programs to evaluate the societal impact of IVHS. Still, it is clear that IVHS can yield substantial benefits widely distributed among our society. There are benefits, for instance, for rural drivers as well as those in congested metropolitan areas; for older as well as younger drivers; and for the current riders of public transportation systems as well as those who will be attracted to public transportation by the enhancements that IVHS helps make possible. The key benefits expected are enumerated below. Because of the anticipated scale of the economic, legal, and social effects of IVHS, it is important that there be penetrating, systematic evaluation of IVHS through the planned operational tests.

## Safety

IVHS brings information and control to the operation of motor vehicles and therefore offers the potential for substantial improvements in traffic safety.

Historically, development of safety features in motor vehicles has alternated between primary systems that help prevent collisions and secondary safety systems that help reduce injuries sustained in a crash. Between 1930 and 1950, the emphasis was on such primary systems as brakes, headlights and signaling. Later, the focus switched to secondary systems such as occupant restraints. Today, the advent of IVHS technologies offers unprecedented opportunities for achieving breakthroughs in crash avoidance features.

Such primary safety systems could warn drivers that they are too close to a car in an adjoining lane or that they are in danger of running off the edge of the road. This may prove of greatest benefit to rural travelers. More than half the fatal accidents in the U.S. occur on rural roads because of poor road conditions and high speeds.

Important infrastructure improvements will also increase safety. For example, new traffic control systems will reduce the number of vehicle stops, minimize variations in vehicle speeds, and enhance traffic flow. All of these, in turn, reduce the number of accidents.

Experts have estimated that IVHS can reduce traffic fatalities by eight percent by 2011. That's 3,300 lives saved and 400,000 injuries avoided each year at current traffic levels. These figures, however, could prove to be quite conservative. If there are breakthroughs in IVHS applications such as collision avoidance, it is possible that there would be a dramatic reduction in the number of crashes, deaths, and injuries.